REMARKS

Reconsideration and allowance of this application, as amended, are respectfully requested. The written description has been editorially revised. Claims 60, 73, 87 and 99 have been amended. Claims 60-83, 85-87, 89, 90, and 94-99 remain pending in the application. Applicant reserves the right to pursue the original claims and other claims in this application and in other applications.

Claims 60-72 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Fan et al. (U.S. Patent 6,171,883) ("Fan") in view of Akio (U.S. Patent 5,691,548), Osawa et al. (U.S. Patent 6,071,443) and Fossum (U.S. Patent 5,887,049). Reconsideration is respectfully requested.

The asserted combination of references would not have rendered obvious the embodiments of the invention defined by any of the rejected claims. The claimed invention would not have been obvious because there is no suggestion or motivation, either in the references or in the knowledge generally available to one of ordinary skill in the art, to combine reference teachings to attain the claimed invention. Fan refers to an image array device (Fig. 2) that has patterned microlenses 24 and an encapsulant layer 25 (column 7, lines 1-10; column 8, lines 45-56). The encapsulant layer 25 in the Fan device is formed of almost any material (column 8, lines 45-56) and is as "thin as is practicable," (column 8, lines 59-63). The coating 25 is thermally annealed and photochemically cured (column 10, lines 20-25). The purpose of the polymer coating 25 is to "inhibit[s] optical degradation of the patterned microlens layer [24]" (column 3, lines 8-9).

Claim 60 recites a microlens array for use in an imaging device. The claimed array (Fig. 3) has a condensing layer 70 and a transparent insulation layer 72. The purpose of the insulation layer 72 is to increase the proportion of radiation incident on the photosensitive elements by capturing light at the edges of the pixel sensor cells, thereby improving the fill factor of the microlens array (specification, page 8, lines 25+; page 3, lines 12-14). The condensing layer 70 is formed of a thermally reformed material (page

10, lines 5+), whereas the insulation layer 72 includes silicon material and is formed on the condensing layer 70 by a low temperature process (page 10, lines 25+).

Neither Fan nor any of the other prior art cited in the Office Action discloses or suggests the insulation layer of amended claim 60, which "increas[es] the proportion of radiation incident on said pixel sensor cells" and which "includes silicon insulator material and is formed . . . by a low temperature process." These are important aspects of the claimed invention. Consequently, claim 60 as amended should be considered allowable over the prior art of record.

Although the Office Action (page 3, paragraph 1) states Fan teaches an "insulation layer 25 including silicon insulator such as silicon nitride," citing column 7, lines 42-43 of Fan, the portion of Fan relied upon in the Office Action actually refers to a "*blanket passivation layer*...formed of silicon nitride" (emphasis added). And, Fan teaches that the encapsulant layer 25 might be formed of "any conformal encapsulant material" (column 8, lines 45-56). This generic reference to a potential universe of materials is not a teaching of the specific silicon material of the present invention, much less a teaching of the recited silicon material formed by a low temperature process to increase the proportion of radiation incident on the pixel sensor cells. See MPEP § 2144.08.

Claims 73-83, 85, and 86 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Fan in view of Akio and Osawa. Claims 87, 89, 90, and 94-98 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Fan in view of Akio and Fossum. Claim 99 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Fan in view of Akio.

Independent claims 73, 87, and 99 have been similarly amended and should be allowable for reasons corresponding to those discussed above in connection with claim 60. Claims 61-72 depend from claim 60; claims 74-83, 85, and 86 depend from claim 73; and claims 89, 90, and 94-98 depend from claim 87. The aforementioned dependent claims should be allowable along with the respective independent claims, and for other reasons.

Applicant's representative also notes that claim amendments similar to those made in the present divisional application were made in the parent application, Rhodes Application No. 09/357,168, and resulted in allowance of all claims and issuance of U.S. Patent No. 6,307,243 on October 23, 2001.

For at least the above reasons, reconsideration and withdrawal of each of the rejections under § 103 are respectfully requested.

Attached hereto is a marked-up version of the changes made to the written description and claims by the current amendment. The first attached page is captioned "**Version with Markings to Show Changes Made**."

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

Dated: April 14, 2003

Respectfully submitted,

By [signature]

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Version with Markings to Show Changes Made

In the Written Description

Page 9, lines 4-23:

The microlens array 22 is manufactured through a process described as follows, and illustrated by Figs. [6] 5 through [9] 8. Referring now to Fig. [6] 5, a substrate 30, which may be any of the types of substrates described above, having a pixel array 26, peripheral circuits, contacts and wiring formed thereon by well-known methods, is provided. A protective layer 24 of BPSG, BSG, PSG, silicon dioxide, silicon nitride or the like is formed over the pixel array 26 to passivate it and to provide a planarized surface. A spacing layer 25 is formed over the protective layer 24. A lens forming layer 80 is formed on the spacer layer 25 by spin-coating or other suitable means. The lens forming layer 80 may be an optical thermoplastic such as polymethylmethacrylate, polycarbonate, polyolefin, cellulose acetate butyrate, or polystyrene, a polyimide, a thermoset resin such as an epoxy resin, a photosensitive gelatin, or a radiation curable resin such as acrylate, methacrylate, urethane acrylate, epoxy acrylate, or polyester acrylate.

Next, as shown in Fig. [7] 6, the lens forming layer 80 is patterned by conventional photolithography, or other suitable means, to form a plurality of lens forming regions 82. In the exemplary embodiment illustrated, each lens forming region 82 overlies a pixel cell 28, although alternative constructions in which a lens forming region 82 overlies multiple pixel cells 28 are foreseen. The shape of the lens forming regions 82 as seen from above may be circular, lenticular, ovoid, rectangular, hexagonal or any other suitable shape.

Paragraph bridging pages 9 and 10, starting at line 24:

Referring now to Fig. [8] 7, the substrate 30 is then treated, by heat treatment or other suitable treatment, to form refractive lenses 70 from the lens forming regions 82. The treatment used to form the refractive lenses 70 depends on the material used to form the lens forming layer 80. If the material of the lens forming layer 80 may be heat treated,

then heat treatment processes such as baking may be used. If the material is extremely photosensitive, then special light exposure techniques may be used, as further described below.

Paragraph bridging pages 10 and 11, starting at line 25:

Fig. [9] 8 shows the next step of the process, in which a transparent insulation layer 72 is formed on the lenses 70 via a low temperature deposition process such as plasma enhanced chemical vapor deposition (CVD). The low temperatures are within the range of approximately 200 to 400 degrees Celsius. The transparent insulation layer 72 may be formed of a silicon insulator such as silicon oxide, silicon nitride, or silicon oxynitride that is transparent to radiation. A CVD process is especially preferred if the transparent insulation layer 72 is formed from silicon oxide, because the CVD process permits the use of tetraethylorthosilicate (TEOS) as the silicon source, as opposed to silane, and therefore results in improved conformal deposition.

Paragraph on page 11, lines 9-23:

The microlens array 22 is essentially complete at this stage, and conventional processing methods may now be performed to package the imager 20. Pixel arrays having the microlens arrays of the present invention, and described with reference to Figs. [1-9] 1-8, may be further processed as known in the art to arrive at CMOS, CCD, or other imagers. If desired, the imager 20 may be combined with a processor, such as a CPU, digital signal processor or microprocessor, in a single integrated circuit, and may be used in a processor system such as the typical processor-based system illustrated generally at 400 in Fig. [10] 9. A processor based system is exemplary of a system having digital circuits which could include CMOS or other imager devices. Without being limiting, such a system could include a computer system, camera system, scanner, machine vision system, vehicle navigation system, video telephone, surveillance system, auto focus system, star tracker system, motion detection system, image stabilization system and data compression system for high-definition television, all of which can utilize the present invention.

Paragraph bridging pages 11 and 12, starting at line 24:

As shown in Fig. [10] 9, a processor system such as a computer system, for example, generally comprises a central processing unit (CPU) 444, e.g., a microprocessor, that communicates with an input/output (I/O) device 446 over a bus 452. The imager 20 also communicates with the system over bus 452. The computer system 400 also includes random access memory (RAM) 448, and, in the case of a computer system may include peripheral devices such as a floppy disk drive 454 and a compact disk (CD) ROM drive 456 which also communicate with CPU 444 over the bus 452. The imager 20 is preferably constructed as an integrated circuit, with or without memory storage, which includes a microlens array 22 having an improved fill factor, as previously described with respect to Figs. 1 through 9.

In the Claims

60. (Twice Amended) A method of forming a microlens array for use in an imaging device, said method comprising the steps of:

providing a substrate having an array of pixel sensor cells formed thereon and a protective layer over the cells;

forming a spacer layer in contact with the protective layer;

forming a lens forming layer over and in contact with the spacer layer;

forming a microlens array from said lens forming layer; and

forming a radiation transparent insulation layer on said microlens array for increasing the proportion of radiation incident on said pixel sensor cells, wherein said insulation layer includes [including] silicon insulator material [on said microlens array] and is formed by a low temperature process.

73. (Twice Amended) A method of forming a microlens array for use in an imaging device, said method comprising the steps of:

forming a lens forming layer on an imaging device;

treating said lens forming layer to form a plurality of microlenses; and

depositing a radiation transparent insulation layer on each microlens for increasing the proportion of radiation incident on said pixel sensor cells, wherein said insulation layer includes silicon insulator material and is formed by a low temperature process [at a temperature within the range of approximately 200° to 400° C, wherein the radiation transparent layer includes silicon insulator material].

87. (Twice Amended) A method of forming a microlens array for use in an imaging device, said method comprising the steps of:

forming a lens forming layer of radiation curable resin on an imaging device;

patterning said lens forming layer to form a plurality of lens forming regions;

treating said plurality of lens forming regions with a radiation exposure step to form a plurality of microlenses; and

forming a radiation transparent insulation layer on the plurality of microlenses for increasing the proportion of radiation incident on said pixel sensor cells, wherein said insulation layer includes [including] silicon insulator material [on the plurality of microlenses] and is formed by a low temperature process.

99. (Twice Amended) A method of forming a microlens array for use in an imaging device, said method comprising the steps of:

forming a lens forming layer on an imaging device, wherein the lens forming layer is a layer of material selected from the group consisting of optical thermoplastic, polyimide, and thermoset resin;

patterning said lens forming layer to form a plurality of lens forming regions;

heat treating said plurality of lens forming regions to form a plurality of microlenses; and

depositing a radiation transparent insulation layer on the plurality of microlenses for increasing the proportion of radiation incident on said pixel sensor cells, wherein said insulation layer includes [including] silicon insulator material [on the plurality of microlenses] and is formed by a low temperature process [at a temperature within the range of approximately 200 to 400 degrees Celsius].